CLAIMS

The invention claimed is:

1. A wet etching method of removing silicon from a substrate, comprising:

depositing a layer comprising silicon in elemental form over a substrate; and

exposing the layer to an aqueous liquid etching solution comprising a hydroxide and a fluoride, and having a pH of at least 10, under conditions and for a period of time effective to etch the elemental silicon from the substrate.

2. The method of claim 1 wherein the pH is at least 11.5.

3. The method of claim 1 wherein the pH is at least 12.0.

4. The method of claim 1 wherein the pH is no greater than 13.8.

5. The method of claim 1 wherein the weight percent of all fluoride in the etching solution is from 0.01% to 5% and the weight percent of all hydroxide in the etching solution is from 0.01% to 25%.

6. The method of claim 5 wherein the weight percent of all fluoride in the etching solution is from 0.01% to 0.5% and the weight percent of all hydroxide in the etching solution is from 0.01% to 1%.

7. The method of claim 1 wherein the volumetric ratio of all fluoride to all hydroxide to all water is about 1:5:40 as NH_4F (40% by volume in water):tetramethyl ammonium hydroxide (25% by volume in water):deionized water.

8. The method of claim 1 wherein the hydroxide comprises an ammonium hydroxide.

9. The method of claim 1 wherein the hydroxide comprises an organic hydroxide.

10. The method of claim 9 wherein the organic hydroxide comprises any one or more of tetramethyl ammonium hydroxide, tert-butyl ammonium hydroxide, and quaternary ammonium hydroxide.

11. The method of claim 1 wherein the hydroxide comprises an inorganic hydroxide.

12. The method of claim 11 wherein the inorganic hydroxide comprises an alkali metal hydroxide.

13. The method of claim 1 wherein the fluoride comprises an inorganic fluoride.

14. The method of claim 13 wherein the inorganic fluoride comprises an alkali metal fluoride.

15. The method of claim 13 wherein the inorganic fluoride comprises ammonium fluoride.

16. The method of claim 1 wherein the fluoride comprises an electrolyte with an organic cation.

17. The method of claim 16 wherein the electrolyte with the organic cation is derived from any one or more of tetramethyl ammonium fluoride, tert-butyl ammonium fluoride, and another quaternary ammonium fluoride.

18. The method of claim 1 wherein the hydroxide comprises an organic hydroxide and the fluoride comprises an inorganic fluoride.

19. The method of claim 1 wherein the etching solution consists essentially of water, an organic hydroxide and an inorganic fluoride.

20. The method of claim 1 wherein the layer consists essentially of silicon in elemental form.

21. The method of claim 1 wherein at least a majority of the layer comprises polycrystalline silicon.

22. The method of claim 1 wherein at least a majority of the layer comprises amorphous silicon.

23. The method of claim 1 wherein at least a majority of the layer comprises monocrystalline silicon.

24. The method of claim 1 wherein the layer consists essentially of polycrystalline silicon in elemental form.

25. The method of claim 1 wherein the layer consists essentially of amorphous silicon in elemental form.

26. The method of claim 1 wherein the layer comprising silicon is undoped with any p-type and n-type conductivity enhancing impurity.

27. The method of claim 1 wherein the layer comprising silicon is doped with at least one of p-type and n-type conductivity enhancing impurity.

28. The method of claim 27 wherein the conductivity enhancing impurity is n-type.

29. The method of claim 27 wherein the conductivity enhancing impurity is p-type.

30. The method of claim 1 wherein fluoride presence in the etching solution is effective under the conditions to achieve increased uniformity in amount of silicon removal across the substrate than would otherwise occur under identical conditions for the period of time using an identical etching solution but with absence of fluoride in the etching solution.

31. A wet etching method of removing silicon from a substrate, comprising:

depositing a layer comprising silicon in elemental form over a substrate comprising at least one of an oxide and a nitride; and

exposing the layer to an aqueous liquid etching solution comprising a hydroxide and a fluoride, and having a pH of at least 10, under conditions and for a period of time effective to etch the elemental silicon from the substrate selectively relative to the at least one of an oxide and a nitride.

32. The method of claim 31 wherein the at least one comprises an oxide.

33. The method of claim 31 wherein the at least one comprises a nitride.

34. The method of claim 31 wherein the pH is at least 11.5.

35. The method of claim 31 wherein the pH is at least 12.0.

36. The method of claim 31 wherein the pH is no greater than 13.8.

37. The method of claim 31 wherein the weight percent of all fluoride in the etching solution is from 0.01% to 5% and the weight percent of all hydroxide in the etching solution is from 0.01% to 25%.

38. The method of claim 37 wherein the weight percent of all fluoride in the etching solution is from 0.01% to 0.5% and the weight percent of all hydroxide in the etching solution is from 0.01% to 1%.

39. The method of claim 31 wherein the volumetric ratio of all fluoride to all hydroxide to all water is about 1:5:40 as NH_4F (40% by volume in water):tetramethyl ammonium hydroxide (25% by volume in water):deionized water.

40. The method of claim 31 wherein the hydroxide comprises an ammonium hydroxide.

41. The method of claim 31 wherein the hydroxide comprises an organic hydroxide.

42. The method of claim 41 wherein the organic hydroxide comprises any one or more of tetramethyl ammonium hydroxide, tert-butyl ammonium hydroxide, and another quaternary ammonium hydroxide.

43. The method of claim 31 wherein the hydroxide comprises an inorganic hydroxide.

44. The method of claim 43 wherein the inorganic hydroxide comprises an alkali metal hydroxide.

45. The method of claim 31 wherein the fluoride comprises an inorganic fluoride.

46. The method of claim 45 wherein the inorganic fluoride comprises an alkali metal fluoride.

47. The method of claim 45 wherein the inorganic fluoride comprises ammonium fluoride.

48. The method of claim 31 wherein the fluoride comprises an electrolyte with an organic cation.

49. The method of claim 48 wherein the electrolyte with the organic cation comprises any one or more of tetramethyl ammonium fluoride, tert-butyl ammonium fluoride, and another quaternary ammonium fluoride.

50. The method of claim 31 wherein the hydroxide comprises an organic hydroxide and the fluoride comprises an inorganic fluoride.

51. The method of claim 31 wherein the etching solution consists essentially of water, an organic hydroxide and an inorganic fluoride.

52. The method of claim 31 wherein the layer consists essentially of silicon in elemental form.

53. The method of claim 31 wherein at least a majority of the layer comprises polycrystalline silicon.

54. The method of claim 31 wherein at least a majority of the layer comprises amorphous silicon.

55. The method of claim 31 wherein at least a majority of the layer comprises monocrystalline silicon.

56. The method of claim 31 wherein the layer consists essentially of polycrystalline silicon in elemental form.

57. The method of claim 31 wherein the layer consists essentially of amorphous silicon in elemental form.

58. The method of claim 31 wherein the layer comprising silicon is undoped with any p-type and n-type conductivity enhancing impurity.

59. The method of claim 31 wherein the layer comprising silicon is doped with at least one of p-type and n-type conductivity enhancing impurity.

60. The method of claim 59 wherein the conductivity enhancing impurity is n-type.

61. The method of claim 59 wherein the conductivity enhancing impurity is p-type.

62. The method of claim 31 wherein fluoride presence in the etching solution is effective under the conditions to achieve increased uniformity in amount of silicon removal across the substrate than would otherwise occur under identical conditions for the period of time using an identical etching solution but with absence of fluoride in the etching solution.

63. A method of forming trench isolation within a semiconductor substrate, comprising:

forming a series of isolation trenches within a semiconductor substrate;

depositing silicon in elemental form to within the isolation trenches;

exposing the silicon to an aqueous liquid etching solution comprising a hydroxide and a fluoride, and having a pH of at least 10, under conditions and for a period of time effective to etch only some of the silicon from the trenches; and

after the exposing, depositing an insulative material to within the isolation trenches over silicon remaining within the trenches.

64. The method of claim 63 wherein fluoride presence in the etching solution is effective under the conditions to achieve increased uniformity in amount of silicon removal from among the trenches than would otherwise occur under identical conditions for the period of time using an identical etching solution but with absence of fluoride in the etching solution.